# Maps, GIS & Imagery

## Topics

Lesson 1 – Role in Analysis

Lesson 2 – Cartography
- Maps, Map Projections, Scale, Coordinates
- Global Positional System (GPS)
  - Garmin, TomTom
- GIS
- Imagery (Remote Sensing/Aerial Photography)
- Demonstrations: Google Earth, MapQuest, Google Maps

Lesson 3 – Geospatial Resources and Tools



## Objective

- Describe and demonstrate maps, GIS, GPS, and imagery (remote sensing and photography)
- Describe and demonstrate the utility of these tools

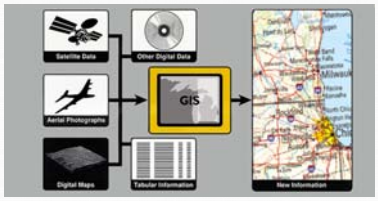
# Lesson 1

## Role of Maps, GIS & Imagery in Analysis

8/16/2012 4

## Locational/Spatial Analytics

- Merges location-based analytics with business information systems and analytical solutions
- Uses map-based visualization to help convey complex ideas in a rich and descriptive form
- Creates new insights that support both strategic and operational decision making




LESSON 1

8/16/2012 5

## Locational/Spatial Analytics For Data Visualization

**SUPPORTS**
- Forecasting
- Trend Analysis
- Segmentation
- Distribution

**NEEDS**
- Measurement
- Metrics
- Numbers

**SHOWS**
- Adjacency
- Relationships
- Trends
- Co-occurrence
- Distance
- Location

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## Role of Maps, GIS & Imagery in Analysis

- Location of event
- Quantity
- Change(s)
- Outcome of change(s)
- Relationship between event and location?
- Factors or variables?
- Patterns or trends?
- Available tools

8/16/2012 7

## Role of Maps, GIS, & Imagery in Analysis- Examples

- Underground hazardous waste sites
- Monitoring wear and tear or damage infrastructure
- Targeting businesses and customers
- Locating shipwrecks, plane wrecks, main highways and bridges, illegal crops, drought stricken areas, climate change
- Planning for urban and rural land uses
- Locating archeological ruins, medical facilities

LESSON 1

8/16/2012 8

## Role of Maps, GIS, & Imagery in Analysis - Examples

- Foreclosures
- Buried cables
- Shoreline erosion
- Real time locations of airplanes, ships, trucks, cars
- Utility planning
- Disaster and Emergency Response planning
- Emergency station planning, hospital planning, school planning

LESSON 1

8/16/2012 9

# Lesson 2

## Cartography

8/16/2012 10

## Cartography

- The Art and Science of Map Making
- Art/color/size/area/shape in presentation
- Science of mathematics and computers (scale, projections, GIS, imagery)

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8/16/2012 11

## Map

- Visual representation, normally to scale and on a flat medium, of a selection of material or abstract features on, or in relation to, the surface of the Earth or a celestial body
- Graphical representation of earth
  - Terrain features (lakes, mountains, swamps, forests)
  - Cultural features (roads, buildings)
  - Socio-demographic features (age, race, education, disease)

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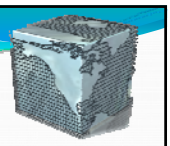
8/16/2012 12

## Map Projections



- Systematic arrangement of meridians and parallels portraying the curved surface of a celestial sphere or spheroid upon a plane
- Spherical properties affected: Area (size), shape, distance, and direction (SSDD)
- On the globe
  - Parallels are parallel and spaced equally on meridians
  - Meridians and other arcs of great circles are straight lines (if looked at perpendicularly to the Earth's surface)

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8/16/2012 13

## Scale

- Scale indicates the relationship between a certain distance on a map or image and the distance on the ground
- Three main methods to indicate scale:
  - Word Statement
  - Bar Graphic
  - Representative Fraction

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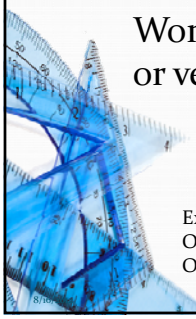
8/16/2012 14

## Word Statement



Word statement or verbal

1 in = 20 mi

1 cm = 10 km

Examples:
One inch equals twenty miles
One centimeter equals ten kilometers

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8/16/2012 15

## Bar Graphic

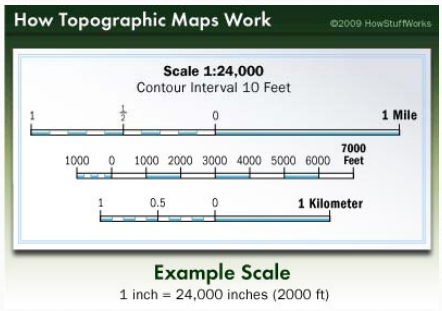


Image: http://static.howstuffworks.com/gif/how-to-read-topographic-map-3.jpg

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## Representative Fraction

**R.F. (Representative Fraction) / Natural)**

**1:1,000,000**

Read as:

- One to a million
- 1:250,000
- 1:23,000
- 1:3,417,217
- 1/250,000
- 1
  ---
  250,000

NOTE: One mile = 63,360 inches

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## Large and Small Scale Maps

**Large Scale Maps**

- Show greater detail but cover a smaller area
- Representative fraction is 1:50,000 or greater (e.g., 1:10,000)

*"It's all in the DETAILS!"*

**Small Scale Maps**

- Show less detail but cover a larger area
- Representative fraction is 1/250,000 to 1/7,500,000

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## Large and Small Scale Maps - Examples

3 views of the same map at different scales

Figure 4a
Scale 1:24000

Figure 4b
Scale 1:62500

Figure 4c
Scale 1:250,000

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8/16/2012 19

## Coordinates

- Latitude and longitude and declination and right ascension are systems of coordinates on the surface of a sphere or globe – Earth and celestial bodies, respectively.
- "A geographic coordinate system uses a three-dimensional spherical surface to define locations on the earth. It includes an angular unit of measure, a prime **meridian**, and a **datum** (based on a **spheroid**). In a geographic coordinate system a point is referenced by its longitude and latitude values. Longitude and latitude are angles measured from the earth's center to a point on the earth's surface. The angles often are measured in degrees (or in grads)."
- Geographic coordinates are important because they are used to geocode features so that they can be mapped and entered into a geographic information system. Coordinates are also associated with other geographic data such as zip codes/postal codes or street addresses.

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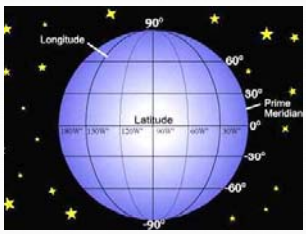
8/16/2012 20

## Geographic Coordinate System




- Lines of latitude run parallel to the equator and divide the earth into 180 equal portions from north to south (or south to north).
- The reference latitude is the equator and each hemisphere is divided into ninety equal portions, each representing one degree of latitude.

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8/16/2012 21

# GPS (Geo/Global Positioning System)

## GPS Videos

- **DR BRIAN COX - GLOBAL POSITIONING SYSTEM – 1:** www.youtube.com/watch?v=Jtmo8puotkI

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## GPS

- Space-based satellite navigation system
- Provides location and time information in all weather, anywhere on or near the Earth, where there is an unobstructed line of sight to four or more GPS satellites
- Maintained by the U.S. government
- Freely accessible to anyone with a GPS receiver
- Provides critical capabilities to military, civil and commercial users around the world
- Backbone for modernizing the global air traffic system

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# What is GIS?

## Geographic Information System

- System that integrates hardware, software, and data for capturing, managing, manipulating, analyzing, and displaying all forms of geographically referenced information
- Merges cartography, statistical analysis and database technology
- Stores spatial features in a coordinate system
- Layers spatial features and associated attributes for mapping and analysis
- Shapefiles, the digital vector format for storing geometric location and associated attribute information
- Used for scientific investigations, resource management, development planning

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8/16/2012 26

## GIS Software

Google Earth

ESRI ArcGIS™

FalconView

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## ArcGIS

ArcEditor

ArcGIS 3d Analyst

ArcMap

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## FalconView

FalconView

PFPS Google Earth Tool (USAFA)

GIS capability (Georgia Tech)

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## Imagery

- According to 10 United States Code, Section 467:
- "(2)(A) The term "imagery" means, except as provided in subparagraph (B), a likeness or presentation of any natural or manmade feature or related object or activity and the positional data acquired at the same time the likeness or representation was acquired, including -
  - (i) products produced by space-based national intelligence reconnaissance systems; and
  - (ii) likenesses or presentations produced by satellites, airborne platforms, unmanned aerial vehicles, or other similar means.
    - (B) Such term does not include handheld or clandestine photography taken by or on behalf of human intelligence collection organizations."

LESSON 2

8/16/2012 30

## Aerial Photography

*This lidar (laser range finder) may be used to scan buildings, rock formations, etc., to produce a 3D model.*
*- Wikipedia*

Light Detection and Ranging (LiDAR) data capture and processing are typically used for terrain mapping and surface modeling, and for creating photogrammetric products.

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8/16/2012 31

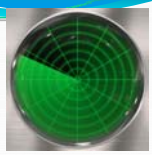
## Remote Sensing

- Technique of obtaining information about objects through the analysis of data collected by special instruments that are not in physical contact with the objects of investigation.
- Regarded as "reconnaissance from a distance," "teledetection," or a form of the common adage "look but don't touch"
- Instruments include photographic cameras, mechanical scanners, radar, sonar, and medical and satellite imaging systems
- Designed to both collect and record specific types of energy that impinges upon them

LESSON 2

8/16/2012 32

## Remote Sensing



- Differentiated in terms of whether they are active or passive
  - Active systems, such as radar and sonar, beam artificially produced energy to a target and record the reflected component
  - Passive systems, including the photographic camera, detect only energy emanating naturally from an object, such as reflected sunlight or thermal infrared emissions

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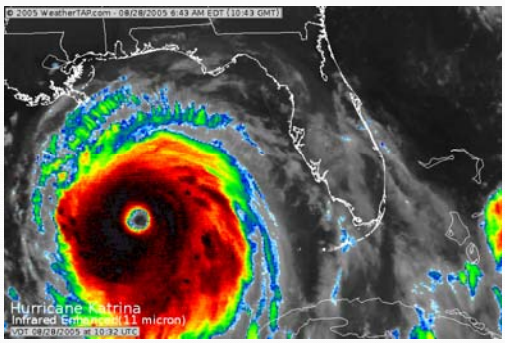
8/16/2012 33

# Examples

## Infra-Red Images of Hurricane Katrina

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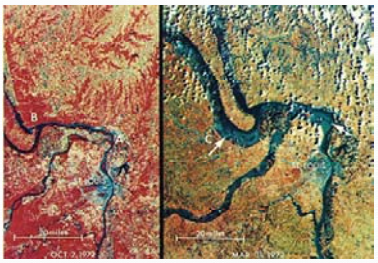
## Images of a River and its Floodplain



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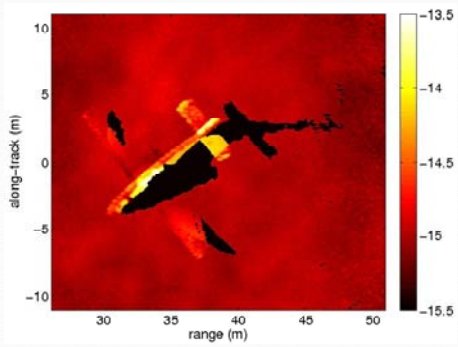
## Image of an Underwater Plane Wreck




LESSON 1

8/16/2012 37

# Lesson 3

## Geospatial Resources and Tools

8/16/2012 38

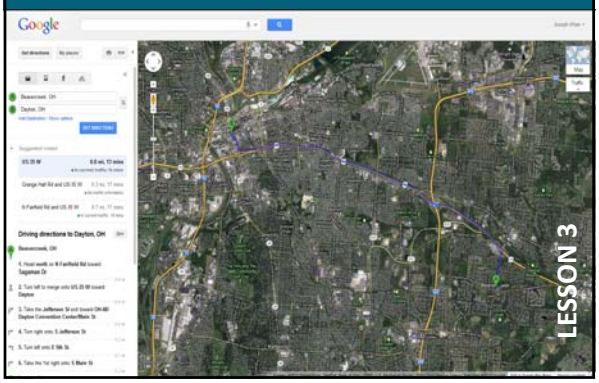
## Geospatial Resources and Tools

- Bing Maps: bing.com/maps
- **Google Maps:** maps.google.com/. **Google Maps: The many Dimensions of a modern map:** http://www.youtube.com/watch?v=U8CMtRS6IUw&feature=relmfu
- **MapQuest:** mapquest.com/. **Introducing the New MapQuest:** www.youtube.com/watch?v=PVJXyMHNi6I&feature=related
- Open Street Map: openstreetmap.org/

LESSON 3

8/16/2012 39

## Google Maps



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## Geospatial Resources and Tools

- Software tools
  - ESRI: esri.com
  - **Google Earth: google.com/earth**
  - USGS National Map: nationalmap.gov
  - GeoCommons: http://geocommons.com/
- Place name links
  - U.S. Board on Geographic Names: geonames.usgs.gov
- Shape Files: http://www.diva-gis.org/gdata
- Latitude/Longitude links
  - Terra Fly: terrafly.com
- Portals
  - **United States Geological Survey: usgs.gov**
  - University of New Hampshire Library: http://docs.unh.edu/links/carto.htm
- Publishers and Sources (International, Federal, State, Local, Commercial)
  - Digital Globe: digitalglobe.com

LESSON 3

8/16/2012 41

## Google Earth

Side by Side comparison

Flight Simulator

Sky Mode

LESSON 3

## Finding Latitude/Longitude

- Google Earth: google.com/earth
- iTouchMap.com: itouchmap.com/latlong.html
- Maporama: maporama.com
- Terraserver: terraserver.com

LESSON 3

8/16/2012 43

## Imagery Search Engines

- Ask Images: ask.com/pictureslanding
- Bing Images: www.bing.com/images?FORM=Z9LH
- BUBL LINK: bubl.ac.uk/link/types/images.htm
- Flickr: flickr.com
- Google Images: images.google.com
- Yahoo Images: images.search.yahoo.com

LESSON 3

8/16/12 44

## Imagery and Geospatial Sites

- Astrium: www.astrium-geo.com/na/
- Defense Imagery: defenseimagery.mil
- Digital Librarian – Images: digital-librarian.com/images.html
- FlashEarth: flashearth.com
- Geo.Data.gov: http://geo.data.gov/geoportal/catalog/main/home.page

LESSON 3

8/16/2012 45

## Imagery and Geospatial Sites

- GISCommons: http://giscommons.org/
- GOES Project Science: rsd.gsfc.nasa.gov/goes/goesproject.html
- Microsoft Research Maps: msrmaps.com
- NASA's Imaging Radar: southport.jpl.nasa.gov

LESSON 3

8/16/2012 46

## Imagery and Geospatial Sites

- NASA's Visible Earth: visibleearth.nasa.gov
- National Geospatial-Intelligence Agency Products & Services: www1.nga.mil/ProductsServices/Pages/default.aspx
- Naval Postgraduate School Dudley Knox Library Map and Imagery Resources: www.nps.edu/Library/Research%20Tools/Subject%20Guides%20by%20Topic/Resources%20by%20Type/Maps/Maps.html

LESSON 3

8/16/2012 47

## Imagery and Geospatial Sites

- Terraserver: terraserver.com
- U.S. Army Center of Military History – images: history.army.mil/html/artphoto/photographs.html
- U.S. Geological Survey's Earth Resources Observation and Science (EROS) Center: eros.usgs.gov
- Wikimapia: wikimapia.org

LESSON 3

8/16/2012 48

## Mashups and GIS Tools

**Mashups**

- Cellreception : cellreception.com
- **Mappy: mappy.com**

**GIS Tools**

- ArcGIS: esri.com
- Falconview/PFPS: falconview.org
- GPS Visualizer: gpsvisualizer.com/
- Regional and State Online Resource for Emergency Management (RaSOR-EM): jsrts.ctc.com

LESSON 3

8/16/2012 49

## Practice Exercises

1. Find the latitude and longitude of Riverside Research using Google Earth.
2. Locate two hotels near Riverside Research using Bing Maps.
3. What are the three ways in which map scale is stated?
4. Find and compare the driving directions from the Dayton airport to Riverside Research using MapQuest and Google Maps.
5. What site gives choices of hotels near my location of interest?
6. What agency is responsible for publishing topographic maps of the United States?

LESSON 3

8/16/2012 50

## Practice Exercises

7. Which is the larger scale map - 1:24,000 or 1:250,000?
8. Name two types of grid systems.
9. Which sites provides directions to places?
10. What is GIS?
11. What does GPS mean?
12. What is geo-coding?
13. Paste a map of 2 restaurant locations from Google Earth into a Google document.
14. Using Google Maps, determine the best time to drive in Washington D.C.

LESSON 3

8/16/2012 51

# Hands-on Exercises

## Hands-on Exercises

1. Find an aerial photograph or a satellite image of the University of Dayton.
2. Find the coordinates for the Dayton airport
3. Find a map of the Dayton airport.
4. Find the address, satellite image, and map of the Lima Tank Plant.
5. Find a satellite image and map of the Patterson Air Force Base.

LESSON 3

8/16/2012 53